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TRANSLATOR'S AFFIDAVIT

I, Herbert Dubno, a citizen of the United States of America, residing in Bronx (Riverdale), New York, depose and state that:

I am familiar with the English and German languages;

I have read a copy of the German-language document attached hereto, namely PCT Application PCT/EP03/01814 published as WO 03/083144; and

The hereto-attached English-language text is an accurate translation of the above-identified German-language document.

Herbert Dubno

Sworn to and subscribed before me
26 July 2004

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METHOD OF TREATING ALLOYED CARBON-CONTAINING IRON MELTS FOR PRODUCING STEEL

The invention relates to a method of treated alloyed carbon containing iron melts for producing steel, whereby in a metallurgical vessel a carbon-containing iron melt is subjected to a decarburization by the addition of oxygen and a part of the metallic alloying elements are slagged, whereby the metal melt is withdrawn from the metallurgical vessel while the slag remains unreduced in the metallurgical vessel and then the metallurgical vessel is filled with a new charge of iron melt and a decarburization process is carried out anew.

The production of stainless chromium steels and chromium nickel steels is usually carried out in a two stage metallurgical process. Initially chromium-containing scrap is smelted in an electric arc furnace and then charged into a further vessel there to be refined and alloyed to the desired composition. In the known converter processes for the production of high-chromium-containing steels like the AOD (argon-oxygen-decarburization) process or the AOD-L ([AOD process] with lance), the MRP (metal refining process) or MRP-L ([EMRP process] with lance), the CLU process or the ASM

process, the main decarburization reaction is carried out in a multicomponent system, whereby the reduction of chromium oxide with carbon occurs alongside direct reduction of the carbon through the basic mechanism. Following the oxidation of the chromium, the chromium oxide is reduced by the carbon dissolved in the melt whereby the carbon monoxide which arises is carried off in the gas atmosphere above the melt.

Because of the incompleteness of this chromium reduction during the decarburization, a part of the chromium oxide is found in the form of various spinels in the slag. The reduction effect decreases with increasing decarburization since the carbon content as the reduction element falls with time.

The economy of the process depends upon recovery of the chromium oxide from the slag of the metal melt. In accordance with conventional processes for this purpose at the end of each decarburization process or each oxygen below, the reduction of the slag is carried out with silicon carriers. To the melt, for example, high purity silicon is added in the form of FeSi in order to reduce the chromium oxide in the slag under strong agitation. The chromium content of the metal bath then rises again.

In order to simplify such a process and make it even more economical, WO 00/79014 proposes the recovery of metallic chromium from chromium-oxide-containing slag which at the end of a blowing or treatment process in a converter or vacuum apparatus from which the slag is tapped in nonreduced form and charged into an electric furnace. This electric furnace is additionally filled with a charge of scrap and optionally residual dust; Carbon and optionally silicon are then fed to it. During the smelting of the charge, the chromium oxide in the slag is reduced by the supplied carbon and silicon directly to metallic chromium. The conventional treatment step of slag reduction directly following the first smelting process is omitted.

JP 9184007 describes a method of treating a melt of a stainless steel utilizing a chromium-rich slag. In this case, molten crude iron is fed to a vessel with retained chromium containing slag from the previous charge and is blown then with oxygen. The chromium oxide in the slag is reduced with carbon and passes as metallic chromium into the melt. An intermediate slagging is then carried out followed by a renewed blowing process onto the crude iron, thereby producing a new slag. Then the steel

is tapped from the vessel and the slag retained for the next charge in the treatment vessel.

The invention has as its object to so develop further a method of treating an alloyed carbon-containing iron melt for the production of steel that the losses of metallic-expensive-alloying elements by slagging is reduced in the decarburization process. Especially, the slagging of chromium from chromium containing melts should be minimized and the degree of recovery of metallic chromium should be high.

These objects are achieved with the method having the features of claim 1. Advantageous further developments are described in the dependent claims.

According to the invention, without intermediate removal of slag, the slag is increasingly saturated with the metal oxides resulting from a number of decarburization processes of the melt and can counteract the slagging of metallic alloying elements from the melt increasingly because of the growing proportion of metal oxide in the slag. The treatment is carried out without intermediate removal of the slag with a slag which accumulates over a multiplicity of charges of crude iron and a corresponding number of tapping of the steel melt from the vessel. Since no

intermediate slag removal occurs, the concentration of metal oxides in the slag increases and with the increasing concentration the slagging of the alloys from the melt is more and more counteracted, that is the tendency toward metal oxidation drops.

For a saturation or approximate saturation of the slag, a multiplicity of successive decarburization processes, advantageously three or four decarburization processes are required one after the other without slag removal. The enrichment in the slag per decarburization process is not proportional to the metal oxide content but rather there is a drop in the quantity of metal oxide sagged with each decarburization process. With complete saturation of the slag in metal oxide, further slagging is suppressed.

Only when the saturation level of the slag is attained or when the slag reaches approximately complete saturation, is the slag reduced and then the slag withdrawn. During the decarburization process, the slag is mixed strongly with the melt to promote the reaction.

As a consequence, with the present process the metal oxidation is minimized and metallic alloying elements are recovered with a high degree of efficiency, the metal yield of the steel melt is high. Furthermore, the following advantages are obtained:

There is a shortening of the overall treatment time of a melt up to 15 to 20 minutes, depending upon the technology used (AOD, MRP, etc.) since slag need not be withdrawn for each melt charge;

There is a reduction in the FeSi consumption since only after a plurality of melt charges is the slag enriched with metal oxides reduced at the level corresponding to the full metal oxide level;

There is a reduction in the consumption of slag powers since slag is withdrawn for each melt charge;

There is a reduction in the specific oxygen consumption for decarburization;

There is a reduction in the specific inert gas consumption or consumption of gas mixtures;

There is an increase in the operational life of the refractory lining materials;

There is an increase in the operational life of oxygen nozzles and flushing blocks;

There is an improvement in the energy utilization of the converter.

In the following, the method is described in terms of an example of a high chromium containing melt with minimization of the chromium oxidation and with recovery of the metallic chromium

The method is carried out in a known metallurgical vessel, a converter or a vacuum apparatus utilizing a decarburization process with introduction of oxygen and especially with the introduction of oxygen by means of a lance.

In the oxygen blowing process and with the dissociation of the oxygen within the bath, element because of the ratio of the chromium (more than 10 weight percent) and carbon (about 1 weight percent) aside from direct decarburization there is also an oxidation of the metallic chromium to chromium oxide.

$$\{O_2\}=2[O]$$

$$[C]+[O]=\{CO\}$$

$$2[Cr]+3[O]=(Cr_2O_3)$$

The chromium oxide which is formed is enriched at the blowing surface. [i.e. the upper surface of the melt] or the burn spot [produced by the lance at this surface] and is reduced [in the body of the melt] by carbon dissolved in the melt in accordance with the following equation $(Cr_2O_3)+3[C]=2[Cr]+3\{CO\}$.

The metallic chromium returns to the melt and the carbon monoxide is carried off in the gas atmosphere above the melt.

This reduction in the chromium oxide is effected only incompletely so that a portion of the Cr_2O_3 passes into the slag. This reduction effect falls off with increasing decarburization since the carbon content, i.e. the content of the reducing agent, falls off with time.

In accordance with the invention, a plurality of decarburization processes can be carried out one after the other by oxygen blowing so that the proportion of chromium oxide in the slag is raised more and more until the slag is saturated with chromium oxide which counteracts further slagging of metallic chromium. The slag saturated with chromium oxygen is then directly reduced especially with FeSi in accordance with the following equation.

$$2(Cr_2O_3)+3[Si]=4[Cr]+3(SiO_2)$$

The invention relates thus not only to the recovery of metallic chromium but also to all other alloying elements whose slagging may be undesirable. The oxygen for decarburization can also be introduced, aside from a lance, by bottom nozzles in the treatment vessel.